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PhD title: Profiling Movement and Gait Quality in Children's Physical Activity

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*What did I do?*

The overarching aim of this PhD was to characterise and profile children's physical activity movement quality. Further, chapter specific aims were, (1) to verify the validity and reliability of accelerometry in a mechanical and laboratory setting, (2) to characterise and profile movement quality according to body-mass index, and (3) to characterise and profile movement quality during recess and free-play.

*Why did I do it?*

Regular physical activity during childhood is positively associated with a variety of physical, social and psychological factor [1-3]. Whilst there are a plethora of methods and techniques to quantify overall activity or energy expenditure, there is a paucity of research demonstrating objective methods to empirically derive quality of movement and its relationship to health, performance and risk factors [4].

*How did I do it?*

(1) Reliability and validity of raw accelerometry (Slamtracker, ADXL345 sensor, Analog Devices, USA) was assessed using a mechanical turntable operating at known speeds (GPO Stylo, Manchester, UK). Subsequently, 20 children (9-11y) performed fundamental movement skills, consisting of locomotion, fine and gross motor control tasks, and assessed using ankle-mounted accelerometry and three-dimensional kinematics (Vicon, MX13, Oxford, UK).
(2) One-hundred and three children (9-11y) took part in the 20m multi-stage fitness test whilst wearing an ankle-mounted accelerometer. Performance variables assessed were time-to-exhaustion and inferred $\dot{V}O_{2max}$.
(3) Twenty-four children (9-11y) took part in school recess for a period of one-week. Activity was recorded using ankle-mounted accelerometry. Sixty-one children (3-5y) took part in free-play and motor competence assessment using the Movement Assessment Battery for Children (2nd edition).

Classic and novel temporal and frequency domain analyses were conducted, consisting of overall activity, fast Fourier transformation, and variance analysis. Spectral purity derived movement quality (SPMQ) was computed using the fundamental frequency spectrum measured from the accelerometer. All data underwent hierarchical clustering based on normalised Euclidean distances. Further inferential statistics were conducted to investigate differences and correlations, accordingly.

*What did I find?*

(1) The accuracy and validity of raw accelerometry (absolute variance: <0.001 g, CV: 0.004%, in all axes) was verified. Overall activity during fundamental movement skills remains invariant, whilst large kinematic and kinetic variance can be detected (CV: 65%).
(2) High BMI was significantly and negatively correlated with SPMQ ($P$<0.05), and hierarchically clustered with stride profile. Time-to-exhaustion was hierarchically clustered with SPMQ. Stride profile was significantly different between BMI classifications.
(3) In 9-11y children, overall activity during recess was invariant day-to-day, yet significant daily differences were found for SPMQ ($P$<0.05). Overall activity was hierarchically clustered with SPMQ, in addition to a significant positive correlation between overall activity and SPMQ ($P$<0.05), whilst BMI percentile was negatively correlated with integrated acceleration and SPMQ. In 3-5y children, there were significant differences between motor competency classifications for SPMQ and integrated acceleration ($P$<0.001). SPMQ was hierarchically clustered with motor competence and overall activity. Significant positive correlations were found between SPMQ, integrated acceleration and motor competence ($P$<0.001).

*What is the most important clinical impact / practical application*

Children's movement quality can be reliably assessed using accelerometers. The movement quality measure coined in this thesis, spectral purity, was indicative of performance, physical activity and motor competence. This PhD has expanded the current evidence base on children's physical activity and movement quality and demonstrated that raw accelerometry can be used to provide innovation in *how* children move. The idea that measuring overall activity in children is enough is incomplete. Movement quality varies between children, and is impacted by age, body weight status and activity levels. This finding should encourage practitioners and researchers to consider not only *quantity*, but the *quality* of children's activity, particularly in relation to school and home-based interventions.

References


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